

CLAIMS

1. A turbofan engine comprising:

a first fan, a second fan, and a multistage compressor joined in serial flow communication for pressurizing air;

a combustor disposed at a discharge end of said compressor for mixing fuel with said pressurized air to form combustion gases;

a first turbine following said combustor and joined by a first shaft to said compressor;

a second turbine following said first turbine and joined to said second fan by a second shaft;

a third turbine following said second turbine and joined to said first fan by a third shaft;

a first cooling circuit joined to an intermediate stage of said compressor for channeling first-pressure air through the center of said first turbine;

a second cooling circuit joined to another intermediate stage of said compressor for channeling second-pressure air to the aft side of said first turbine;

a third cooling circuit joined to said discharge end of said compressor for channeling third-pressure air to the forward side of said first turbine; and

wherein said first, second, and third cooling circuits are joined to sequential stages of said compressor for extracting therefrom said first-pressure air, said second-pressure air, and said third-pressure air at correspondingly increasing pressure and temperature.

2. An engine according to claim 1 wherein:

said second turbine comprises a second rotor disk having a second center bore and a row of second rotor blades extending radially outwardly from a perimeter rim thereof;

said third turbine comprises a third rotor disk having a third center bore and a row of third rotor blades extending radially outwardly from a perimeter rim thereof, and a third turbine nozzle disposed between said second and third blades;

said second blades re disposed aft of said first blades without a turbine nozzle therebetween; and

said second cooling circuit extends radially inwardly through said third nozzle, axially forward through said second bore, and between the opposing sides of said first and second disks.

3. An engine according to claim 2 wherein said third turbine nozzle includes variable position hollow vanes, and said cooling circuit extends through said vanes to said second bore.

4. An engine according to claim 3 wherein:

said first turbine comprises a first rotor disk having a first center bore and a row of first rotor blades extending radially outwardly from a perimeter rim thereof; and

said first cooling circuit extends through said bore, said second cooling circuit extends radially outwardly along the aft side of said disk, and said third circuit extends radially outwardly along the forward side of said disk.

5. An engine according to claim 4 wherein said second cooling circuit is radially split to flow in part through said second bore and in remaining part along the aft side of said second disk.

6. An engine according to claim 5 wherein:

said second cooling circuit includes a stationary second inducer for tangentially accelerating said second-pressure air around said second rotor disk; and

said third cooling circuit includes a stationary third inducer for tangentially accelerating said third-pressure air around said first rotor disk.

7. An engine according to claim 6 wherein:

said first turbine further includes a forward blade retainer spaced in part from said first disk, and having a row of apertures aligned with said third inducer for receiving said third-pressure air therefrom; and

said second turbine further includes an aft blade retainer spaced in part from said second disk, and having a row of apertures aligned with said second inducer for receiving said

second-pressure air therefrom.

8. An engine according to claim 6 wherein:

said first turbine further includes a thin web extending radially inwardly from said rim followed by a thicker hub containing said first center bore; and

said first shaft is hollow and extends from said forward and aft sides of said first turbine between said web and hub thereof to define in part said first cooling circuit for cooling said first turbine hub.

9. An engine according to claim 6 wherein said first and second rotor blades are oppositely configured for rotating said second shaft in counterrotation with said first shaft.

10. An engine according to claim 6 wherein each of said first, second, and third cooling circuits includes corresponding seals to isolate from each other said forward side, aft side, and first bore of said first turbine and provide cooling thereof with different temperature cooling air.

11. A turbofan engine comprising:

a first fan, a second fan, and a multistage compressor joined in serial flow communication for pressurizing air;

a combustor disposed at a discharge end of said compressor for mixing fuel with said pressurized air to form combustion gases;

a first turbine following said combustor and joined by a first shaft to said compressor;

a second turbine following said first turbine and joined to said second fan by a second shaft;

a third turbine following said second turbine and joined to said first fan by a third shaft;

a first cooling circuit joined to an intermediate stage of said compressor for channeling first-pressure air through the center of said first turbine;

a second cooling circuit joined to another intermediate stage of said compressor for

channeling second-pressure air to the aft side of said first turbine; and

a third cooling circuit joined to said discharge end of said compressor for channeling third-pressure air to the forward side of said first turbine.

12. An engine according to claim 11 wherein:

said first turbine comprises a first rotor disk having a first center bore and a row of first rotor blades extending radially outwardly from a perimeter rim thereof; and

said first cooling circuit extends through said bore, said second cooling circuit extends radially outwardly along the aft side of said disk, and said third circuit extends radially outwardly along the forward side of said disk;

13. An engine according to claim 12 wherein:

said second turbine comprises a second rotor disk having a second center bore and a row of second rotor blades extending radially outwardly from a perimeter rim thereof;

said third turbine comprises a third rotor disk having a third center bore and a row of third rotor blades extending radially outwardly from a perimeter rim thereof, and a third turbine nozzle disposed between said second and third blades;

said second blades are disposed aft of said first blades without a turbine nozzle therebetween; and

said second cooling circuit extends radially inwardly through said third nozzle, axially forward through said second bore, and between the opposing sides of said first and second disks.

14. An engine according to claim 13 wherein said second cooling circuit is radially split to flow in part through said second bore and in remaining part along the aft side of said second disk.

15. An engine according to claim 13 wherein:

said second cooling circuit includes a stationary second inducer for tangentially accelerating said second-pressure air around said second rotor disk; and

said third cooling circuit includes a stationary third inducer for tangentially accelerating said third-pressure air around said first rotor disk.

16. An engine according to claim 15 wherein:

said first turbine further includes a forward blade retainer spaced in part from said first disk, and having a row of apertures aligned with said third inducer for receiving said third-pressure air therefrom; and

said second turbine further includes an aft blade retainer spaced in part from said second disk, and having a row of apertures aligned with said second inducer for receiving said second-pressure air therefrom.

17. An engine according to claim 16 wherein:

said first turbine further includes a thin web extending radially inwardly from said rim followed by a thicker hub containing said first center bore; and

said first shaft is hollow and extends from said forward and aft sides of said first turbine between said web and hub thereof to define in part said first cooling circuit for cooling said first turbine hub.

18. An engine according to claim 13 wherein said first and second rotor blades are oppositely configured for rotating said second shaft in counterrotation with said first shaft.

19. An engine according to claim 18 wherein said third turbine nozzle includes variable position hollow vanes, and said cooling circuit extends through said vanes to said second bore.

20. An engine according to claim 13 wherein said first, second, and third cooling circuits are joined to sequential stages of said compressor for extracting therefrom said first-pressure air, said second-pressure air, and said third-pressure air at correspondingly increasing pressure and temperature.